Space Technology Research Grants

Reactive Nano Scale Emulsions for High Performance Hybrid Propulsion

Completed Technology Project (2015 - 2019)

Project Introduction

As we enter into a new era of space exploration, with less dependence on foreign technology and more dependence on private industry, persistent innovation is vital to advancing our nation's technological capabilities. Over the past decade, considerable developments have been made in the performance of hybrid propulsion systems. But, further enhancements to the current state of hybrid fuels must be achieved in order to produce a mature technology capable of providing a more effective, affordable, and sustainable means of space exploration. The strategies outlined in this proposal will focus on the development of novel mixture procedures to produce stable multiphase fuel mixtures aimed at increasing the combustion efficiency, specific impulse, and regression rate of hybrid fuels. Low-energy emulsification techniques will be used to create kinetically stable liquid amine-borane-in-paraffin nanoemulsions as a starting point. Following the establishment of an acceptable procedure, these techniques will be extended to include additional liquid fuel additives and fuel binder combinations. The stability of the emulsified fuel mixtures will be measured using dynamic light scattering techniques. Subsequently, these fuel mixtures will be cooled and cast into hybrid fuel grains to evaluate regression rates and combustion performance relative to neat paraffin and neat HTPB fuel grains. Breakthrough solutions will most directly influence NASA's In-Space Propulsion Technology Area Roadmap by contributing less complex and cheaper upper stage motors with regression rates comparable to solid fuels. Preliminary opposed flow burner tests with emulsified TEB-in-paraffin fuel pellets exhibited average regression rates of 2.53 Â± 0.037 mm/s or an increase of approximately 83% and 794% compared to neat paraffin and neat HTPB respectively. Therefore, further research to optimize these mixture techniques could help to enhance the current state of hybrid fuels, potentially transforming NASA's technological capabilities.

Anticipated Benefits

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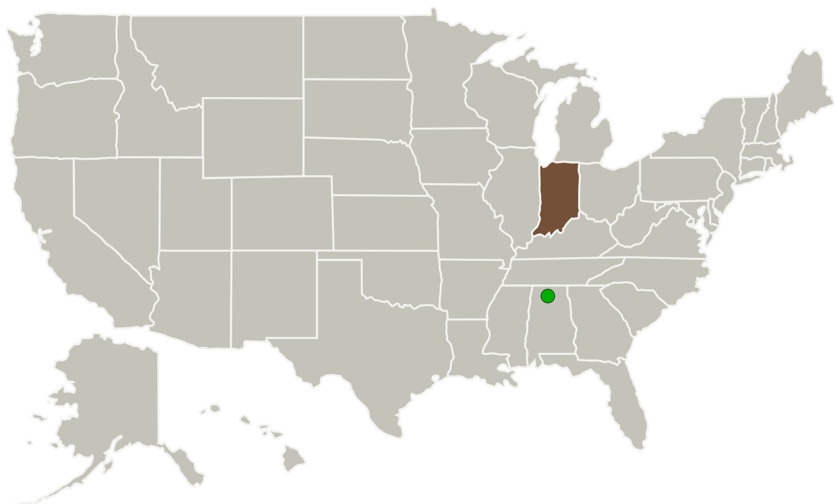
Table of Contents

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Purdue University-Main Campus	Lead Organization	Academia	West Lafayette, Indiana
Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama

Primary U.S. Work Locations
Indiana

Project Website:

https://www.nasa.gov/strg#.VQb6T0jJzyE

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Purdue University-Main Campus

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

Timothee L Pourpoint

Co-Investigator:

Joshua Mathews

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Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**

1	2	3	4	5	6	7	8	9
Applied Research			Development			Demo & Test		

Technology Areas

Primary:

- TX01 Propulsion Systems
  └─ TX01.1 Chemical Space Propulsion
    └─ TX01.1.5 Hybrids

Target Destinations

Earth, The Moon